

Tropical Cyclone Report
Tropical Storm Larry
1-6 October 2003

Stacy R. Stewart
National Hurricane Center
7 December 2003

Tropical Storm Larry developed from a complex low pressure system over the Bay of Campeche. Larry moved inland over southeastern Mexico causing widespread floods which resulted in five deaths.

a. Synoptic History

A tropical wave moved off the coast of western Africa on 17 September. A deep upper-level trough situated over the Lesser Antilles produced hostile vertical shear conditions across much of tropical Atlantic as the wave traversed westward across the region. However, by 26 September, the wave moved west of the trough axis and passed underneath an upper-level anticyclone over the western Caribbean Sea. The favorable upper-level outflow and low-shear environment allowed deep convection to redevelop and consolidate along the wave axis. By the next day, surface observations indicated a weak surface low pressure system had developed along the wave axis a couple hundred miles east of the Yucatan Peninsula of Mexico.

Deep convection continued to develop and become organized around the low-level center, and the system nearly formed into a tropical depression before it moved west-northwestward over the northern Yucatan Peninsula on 29 September. Interaction with the Yucatan land mass arrested the development process, and the entrainment of dry mid-level air later that afternoon likely caused the deep convection to weaken and become disorganized. By early 30 September, surface observations from ships and buoys, along with conventional satellite imagery, indicated the warm core tropical low had crossed into the southern Gulf of Mexico and merged with a stationary frontal boundary. The air mass to the north and west of the front was unusually cool and dry, and surface pressures were higher than typically seen with early season cold outbreaks. The unseasonably strong surface high pressure system located over the northern Gulf of Mexico combined with the low pressure area and strengthened the pressure gradient and the low-level wind between the two systems. This resulted in a large area of gale force winds over the central and southern Gulf of Mexico, including the Bay of Campeche. An Air Force Reserve reconnaissance flight at 2119 UTC later that day confirmed that cool, stable air had been drawn into the low-levels of the system suggesting that the cyclone had acquired extratropical characteristics, at least below the 700 mb-level.

By early 1 October, the low had drifted slowly westward into the Bay of Campeche, and significant deep convection had re-developed northeast and southwest of the broad low-level center. The convection continued to become better organized into curved band features during the day and

the gale center gradually began to take on a convective appearance more reminiscent of a tropical cyclone. However, a reconnaissance flight at 1833 UTC indicated the cool, dry air low-level air had moistened considerably and had also warmed by more than 3° C, suggesting that the extratropical low had made the transition into Tropical Storm Larry at 1800 UTC that day about 260 n mi east-southeast of Tampico, Mexico. The “best track” chart of the tropical cyclone’s path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1.

Larry was caught in a break in a mid-level subtropical ridge that extended east-west across the Gulf of Mexico from Florida westward into Texas and northern Mexico. The unseasonably strong surface high pressure over the northern Gulf of Mexico contributed to blocking any significant northward motion. The weak steering flow caused Larry to meander slowly westward for the next 2 days. During that time, the cyclone gradually strengthened and reached its peak intensity of 55 kt at 0000 UTC 3 October about 160 n mi east-northeast of Vera Cruz, Mexico. Larry maintained that intensity for almost 3 days afterwards.

While Larry was moving slowly westward, the mid-level ridge over Texas gradually built in behind the strong shortwave trough associated with the earlier cold front. As mid-level ridging and increasing northerly flow developed north and west of Larry, the cyclone moved erratically southward into the southern Bay of Campeche and eventually made landfall around 1000 UTC 5 October along the southeastern coast of Mexico near Paraiso, in the State of Tabasco. Larry steadily weakened as it continued its slow southward trek across the Isthmus of Tehuantepec and became a Tropical Depression at 0600 UTC 6 October before degenerating into a non-convective remnant low pressure just 6 h later over the state of Vera Cruz. The remnant low moved southwestward for next 24 h before emerging over the Gulf of Tehuantepec in the North Pacific Ocean. The weak low gradually opened into a low pressure trough and dissipated at 0000 UTC 8 October about 240 n mi east-southeast of Acapulco, Mexico.

b. Meteorological Statistics

Observations in Tropical Storm Larry (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) and the U. S. Air Force Weather Agency (AFWA), as well as flight-level and dropwindsonde observations from flights of the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command.

Several ships reported gale force or tropical storm force winds associated with Larry. In addition, several oil drilling platforms also observed tropical storm force winds, but these measurements were made more than 100 feet above the surface and may not be representative of actual surface wind conditions. The ship and oil platform reports of winds of tropical storm force associated with Larry are given in Table 2. Selected surface observations from land stations and data buoys are given in Table 3.

Larry's maximum intensity of 55 kt at 0000 UTC 3 October is based on a peak reconnaissance 1500 ft flight-level wind speed of 66 kt at 1932 UTC 2 October (which converts to a surface wind value of about 53 kt). This is also consistent with visual surface wind speed estimates of 55 kt and 60 kt at 1909 UTC and 2319 UTC 2 October, respectively, that were determined by the flight crew.

There were no official storm surge reports received.

Rainfall totals listed in Table 3 are likely not representative of the maximum rainfall that occurred across southeastern Mexico due to lack of sufficient surface observations along the coast and inland. However, the National Meteorological Service of Mexico indicated that heavy rainfall occurred across the states of Vera Cruz and Tabasco causing localized floods and mud slides. The rainfall total of 6.33 in at Villa Hermosa, Mexico was the largest official report received.

No tornadoes were reported.

c. Casualty and Damage Statistics

The Government of Mexico reported 5 deaths associated with Tropical Storm Larry. The deaths were caused by heavy rainfall-induced freshwater floods.

d. Forecast and Warning Critique

Average official track errors (with the number of cases in parentheses) for Tropical Storm Larry were 29 (17), 44 (15), 56 (13), 76 (11), 114 (7), and 191 (3) n mi for the 12, 24, 36, 48, 72, and 96 h forecasts, respectively¹ (Table 4) These errors are exceptionally lower than the average official track errors for the 10-yr period 1993-2002² (45, 81, 116, 150, 225, and 282 n mi, respectively). While the first few forecasts showed a general westward motion toward the east-central Mexican coast, subsequent forecasts correctly indicated a slow southward motion toward the southeastern coast of Mexico where landfall eventually occurred (Fig. 4). Although the slow forward speed of Larry may have contributed to the small track forecast errors, the forecast process was not as straight-forward as one might first assume. On several occasions, the numerical model guidance varied widely in both direction (some cases had model tracks in all directions) and forward speed.

¹ All forecast verifications in this report include the depression stage of the cyclone. National Hurricane Center verifications presented in these reports prior to 2003 did not include the depression stage.

² Errors given for the 96 period is an average over the two-year period 2001-2.

Average official intensity errors were 4, 5, 7, 10, 16 and 27 kt for the 12, 24, 36, 48, 72, and 96 h forecasts, respectively. For comparison, the average official intensity errors over the 10-yr period 1993-2002 are 6, 10, 13, 15, 19, and 21 kt, respectively. The higher than average error at 96 h was mainly due the first 3 forecasts indicating that Larry was expected to remain over the Bay of Campeche and strengthen to just below hurricane intensity. Once it became apparent that a large high pressure ridge to the north would drive Larry southward over Mexico, subsequent intensity forecasts showed significant weakening over land. However, those forecasts were not verified since the cyclone degenerated into a non-convective remnant low over land and over the eastern North Pacific Ocean.

In addition, the lack of significant development beyond the 55 kt peak intensity obtained on 3 October was mainly due to northerly upper-level shear and the entrainment of cool, dry mid-level air. The combination of these two environmental factors prevented deep convection from developing and wrapping around the low-level center. The effect of the northerly vertical shear was indicated by satellite imagery showing little or no outflow and a general sharp edge to the cirrus clouds in the northern semicircle.

The Tropical Analysis and Forecast Branch issued a gale warning for the pre-Larry extratropical low pressure system about 24 h before the it acquired tropical characteristics and made the transition into a tropical storm.

Table 5 lists the watches and warnings associated with Tropical Storm Larry. Due to the uncertainty in the exact direction and speed of motion that Larry would assume after it became a tropical storm, the Government of Mexico's tropical storm warnings and hurricane watches were issued approximately 61 h in advance of the time of landfall.

Table 1. Best track for Tropical Storm Larry, 1-6 October 2003.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|--------------------|------------------|-------------------|------------------|--------------------|--------------------|
| 27 / 1800 | 18.5 | 84.7 | 1009 | 15 | low |
| 28 / 0000 | 18.7 | 84.9 | 1009 | 15 | " |
| 28 / 0600 | 19.0 | 85.3 | 1008 | 20 | " |
| 28 / 1200 | 19.3 | 86.0 | 1008 | 20 | " |
| 28 / 1800 | 19.7 | 86.9 | 1008 | 20 | " |
| 29 / 0000 | 20.0 | 87.5 | 1007 | 20 | low over Yucatan |
| 29 / 0600 | 20.3 | 88.2 | 1007 | 20 | " |
| 29 / 1200 | 20.6 | 88.9 | 1007 | 20 | " |
| 29 / 1800 | 21.0 | 89.6 | 1007 | 20 | " |
| 30 / 0000 | 21.2 | 90.5 | 1007 | 25 | extratropical low |
| 30 / 0600 | 21.4 | 91.5 | 1007 | 25 | " |
| 30 / 1200 | 21.3 | 92.1 | 1007 | 30 | " |
| 30 / 1800 | 21.2 | 92.5 | 1006 | 35 | extratropical gale |
| 01 / 0000 | 20.9 | 92.9 | 1006 | 40 | " |
| 01 / 0600 | 20.9 | 92.9 | 1005 | 40 | " |
| 01 / 1200 | 21.0 | 93.0 | 1004 | 40 | " |
| 01 / 1800 | 21.0 | 93.2 | 1003 | 45 | tropical storm |
| 02 / 0000 | 20.9 | 93.4 | 1002 | 45 | " |
| 02 / 0600 | 20.7 | 93.4 | 1000 | 45 | " |
| 02 / 1200 | 20.5 | 93.4 | 998 | 45 | " |
| 02 / 1800 | 20.4 | 93.6 | 996 | 50 | " |
| 03 / 0000 | 20.5 | 94.0 | 993 | 55 | " |
| 03 / 0600 | 20.3 | 94.3 | 994 | 50 | " |
| 03 / 1200 | 20.1 | 94.5 | 994 | 50 | " |
| 03 / 1800 | 19.9 | 94.7 | 995 | 50 | " |

| | | | | | |
|-----------|------|------|------|----|--------------------------------------|
| 04 / 0000 | 19.6 | 94.5 | 995 | 50 | " |
| 04 / 0600 | 19.5 | 94.0 | 994 | 50 | " |
| 04 / 1200 | 19.3 | 93.8 | 994 | 50 | " |
| 04 / 1800 | 18.8 | 93.8 | 996 | 50 | " |
| 05 / 0000 | 18.6 | 93.6 | 996 | 50 | " |
| 05 / 0600 | 18.5 | 93.5 | 996 | 50 | " |
| 05 / 1200 | 18.4 | 93.5 | 997 | 50 | tropical storm |
| 05 / 1800 | 18.2 | 93.7 | 1000 | 40 | " |
| 06 / 0000 | 17.9 | 93.8 | 1003 | 35 | " |
| 06 / 0600 | 17.5 | 93.9 | 1005 | 25 | tropical depression |
| 06 / 1200 | 17.2 | 94.1 | 1006 | 20 | remnant low |
| 06 / 1800 | 16.9 | 94.3 | 1006 | 20 | " |
| 07 / 0000 | 16.6 | 94.5 | 1007 | 15 | " |
| 07 / 0600 | 16.3 | 94.7 | 1007 | 15 | " |
| 07 / 1200 | 16.0 | 95.0 | 1008 | 15 | remnant low over Northern Pacific |
| 07 / 1800 | 15.8 | 95.3 | 1009 | 15 | " |
| 08 / 0000 | | | | | dissipated |
| 05 / 1000 | 18.4 | 93.5 | 996 | 50 | landfall near Paraiso, Mexico |
| 03 / 0000 | 20.5 | 94.0 | 993 | 55 | minimum pressure |

Table 2 Selected ship and oil drilling platforms with winds of at least 34 kt or significant surface pressure values for Tropical Storm Larry, 1-6 October 2003, including extratropical gale stage.

| Date/Time (UTC) | Ship call sign | Latitude (°N) | Longitude (°W) | Wind dir/speed (kt) | Pressure (mb) |
|----------------------------|-------------------|---------------|----------------|---------------------------|---------------|
| 29 / 1800 | 3FPQ9 | 25.8 | 87.7 | 030 / 35 | 1013.0 |
| 02 / 0300 | ELXU6 | 19.8 | 94.8 | 280 / 46 | 1008.4 |
| 02 / 1800 | S6HF | 19.1 | 94.1 | 300 / 40 | 1009.0 |
| 02 / 1800 | ZIYE7 | 19.9 | 96.2 | 320 / 50 | 1006.0 |
| 02 / 2100 | ZIYE7 | 20.5 | 96.5 | 280 / 48 | 1005.5 |
| 03 / 0000 | S6HF | 19.3 | 94.1 | 280 / 45 | 1009.0 |
| 03 / 0000 | ZIYE7 | 21.2 | 96.9 | 340 / 44 | 1006.5 |
| 03 / 0600 | ZIYE7 | 22.3 | 97.5 | 340 / 40 | 1010.5 |
| 03 / 0900 | ZIYE7 | 22.6 | 97.5 | 340 / 37 | 1010.0 |
| Oil Platforms ^a | | | | | |
| 30 / 1200 | Whittington | 20.1 | 96.4 | W / 39 | 1011.8 |
| 30 / 2000 | Whittington | 20.1 | 96.4 | W / 39 | 1008.8 |
| 01 / 1200 | Ambassador | 18.6 | 94.5 | NNW / 48 G 52 | |
| 02 / 0000 | Ambassador | 18.6 | 94.5 | NW / 48 G 52 | |
| 02 / 0600 | Ambassador | 18.6 | 94.5 | NW / 35 G 43 | |
| 02 / 0600 | Whittington | 20.1 | 96.4 | W / 43 G 52 | 1007.1 |
| 02 / 1130 | Worker | 19.35 | 92.95 | SW / 78 G 91 ^b | 1013.9 |
| 02 / 1200 | Dos Bocas (Boyas) | 18.65 | 93.15 | W 35 G 40 | 1005.9 |
| 02 / 1200 | FSO Ta'Kuntah | 19.65 | 92.1 | | 1005.0 |
| 02 / 1200 | Ixtoc-A | 19.4 | 92.2 | | 1006.4 |
| 02 / 1230 | Whittington | 20.1 | 96.4 | W / 43 G 54 | 1008.1 |
| 02 / 1600 | Whittington | 20.1 | 96.4 | W / 43 G 52 | 1005.1 |
| 02 / 1700 | Whittington | 20.1 | 96.4 | W / 43 G 53 | 1004.4 |

| Date/Time (UTC) | Ship call sign | Latitude (°N) | Longitude (°W) | Wind dir/speed (kt) | Pressure (mb) |
|--------------------|----------------|------------------|-------------------|------------------------|------------------|
| 03 / 1130 | Whittington | 20.1 | 96.4 | W / 38 G 48 | 1009.1 |
| 03 / 1130 | Worker | 19.35 | 92.95 | S / 30 G 35 | |
| 03 / 1130 | Whittington | 20.1 | 96.4 | W / 39 G 54 | 1006.4 |
| 03 / 1130 | Ambassador | 18.6 | 94.5 | WNW / 26 G 35 | 1000.3 |
| 03 / 1500 | Whittington | 20.1 | 96.4 | W / 33 G 37 | 1004.0 |
| 04 / 1400 | Ambassador | 18.6 | 94.5 | WNW / 26 G 35 | 999.6 |
| 05 / 0700 | Ambassador | 18.6 | 94.5 | WNW / 18 G 22 | 999.6 |
| 05 / 1700 | Ambassador | 18.6 | 94.5 | NE / 8 G 13 | 999.6 |

^aPlatform elevations range from 100-400 ft above the surface.

^bQuestionable data.

Table 3. Selected surface observations for Tropical Storm Larry, 1-6 October 2003.

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft) | Storm tide (ft) | Total rain (in) |
|----------------------|----------------------------|-------------|------------------------------|-----------------------------|-----------|------------------|-----------------|-----------------|
| | Date/time (UTC) | Press. (mb) | Date/time (UTC) ^a | Sustained (kt) ^b | Gust (kt) | | | |
| Mexico | | | | | | | | |
| Campeche | | | | | | | | 1.49 |
| Coatzacoalcos | | | | | | | | 1.09 |
| Villa Hermosa | | | | | | | | 6.63 |
| Drifting Buoy | | | | | | | | |
| 41901 (19.3N 95.6W) | 05/1100 | 1011.0 | 05/1100 | | 41 | | | |

^a Date/time is for wind gust.

^b Buoy averaging periods is 8 min.

Table 4. Preliminary forecast evaluation (heterogeneous sample) for Tropical Storm Larry, 1-6 October 2003. Forecast errors (n mi) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Verification includes the depression stage, but does not include the extratropical stage.

| Forecast Technique | Forecast Period (h) | | | | | | |
|-------------------------------------|---------------------|----------------|----------------|---------------|----------------|----------------|-----|
| | 12 | 24 | 36 | 48 | 72 | 96 | 120 |
| CLP5 | 36 (17) | 67 (15) | 127 (13) | 182 (11) | 309 (7) | 435 (3) | |
| GFNI | 28 (10) | 50 (8) | 86 (8) | 114 (6) | 123 (2) | | |
| GFDI | 33 (17) | 51 (15) | 71 (13) | 100 (11) | 140 (5) | 124 (1) | |
| GFDL | 33 (16) | 49 (14) | 71 (12) | 100 (10) | 144 (6) | 169 (2) | |
| GFDN | 39 (7) | 43 (6) | 66 (4) | 95 (4) | 127 (2) | | |
| LBAR | 49 (17) | 111 (15) | 195 (13) | 292 (11) | 549 (7) | 1144 (3) | |
| AVNI | 31 (15) | 52 (13) | 64 (11) | 82 (9) | 111 (5) | 147 (1) | |
| AVNO | 33 (16) | 40 (14) | 60 (12) | 76 (10) | 103 (6) | 102 (2) | |
| AEMI | 38 (12) | 69 (11) | 113 (10) | 160 (8) | 267 (5) | 479 (2) | |
| BAMD | 51 (17) | 100 (15) | 157 (13) | 228 (11) | 462 (7) | 1303 (3) | |
| BAMM | 60 (17) | 115 (15) | 183 (13) | 250 (11) | 321 (7) | 371 (3) | |
| BAMS | 90 (17) | 173 (15) | 265 (13) | 363 (11) | 515 (7) | 736 (3) | |
| NGPI | 29 (15) | 40 (13) | 51 (11) | 58 (9) | 143 (5) | | |
| NGPS | 33 (14) | 37 (12) | 48 (10) | 57 (8) | 106 (4) | | |
| UKMI | 41 (15) | 63 (13) | 78 (11) | 89 (8) | 117 (5) | 183 (1) | |
| UKM | 52 (8) | 69 (7) | 69 (6) | 68 (5) | 103 (3) | 157 (1) | |
| A98E | 33 (17) | 57 (15) | 93 (13) | 145 (11) | 228 (7) | 371 (3) | |
| A9UK | 34 (8) | 65 (7) | 105 (6) | 165 (5) | 251 (3) | | |
| GUNS | 27 (13) | 39 (11) | 48 (9) | 66 (6) | 81 (3) | | |
| GUNA | 29 (13) | 42 (11) | 48 (9) | 69 (6) | 66 (3) | | |
| OFCL | 29 (17) | 44 (15) | 56 (13) | 76 (11) | 114 (7) | 191 (3) | |
| NHC Official (1993-2002 mean) | 45 (2985) | 81 (2726) | 116 (2481) | 150 (2230) | 225 (1819) | 282 (265) | |

Table 5. Watch and warning summary for Tropical Storm Larry, 1-6 October 2003.

| Date/Time (UTC) | Action | Location |
|--------------------|---|--|
| 02 / 2100 | Tropical Storm Warning Issued | Vera Cruz to Campeche, Mexico |
| 02 / 2100 | Hurricane Watch Issued | Vera Cruz to Campeche, Mexico |
| 04 / 0000 | Tropical Storm Warning Extended Northward | Vera Cruz to Tuxpan, Mexico |
| 04 / 0000 | Hurricane Watch Extended Northward | Vera Cruz to Tuxpan, Mexico |
| 05 / 0000 | Tropical Storm Warning Extended Eastward | Campeche to Ciudad Del Carmen, Mexico |
| 05 / 0000 | Hurricane Watch Extended | Campeche to Ciudad Del Carmen, Mexico |
| 05 / 0000 | Tropical Storm Warning Discontinued | Vera Cruz to Tuxpan, Mexico |
| 05 / 0000 | Hurricane Watch Discontinued | Vera Cruz to Tuxpan, Mexico |
| 05 / 1500 | Hurricane Watch Discontinued | Vera Cruz to Ciudad Del Carmen, Mexico |
| 06 / 0300 | Tropical Storm Warning Discontinued | Vera Cruz to Ciudad Del Carmen, Mexico |

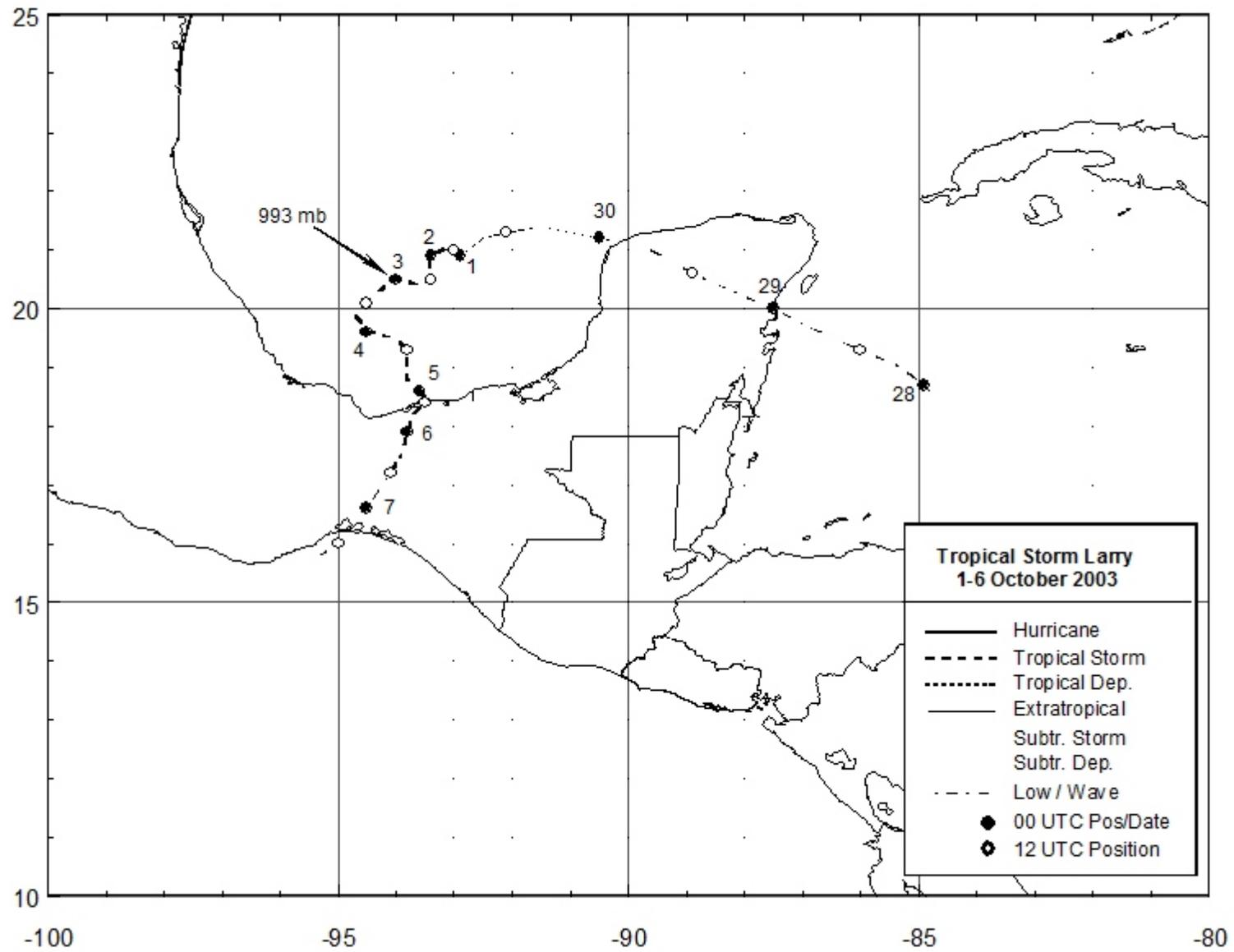


Figure 1. Best track positions for Tropical Storm Larry, 1-6 October 2003.

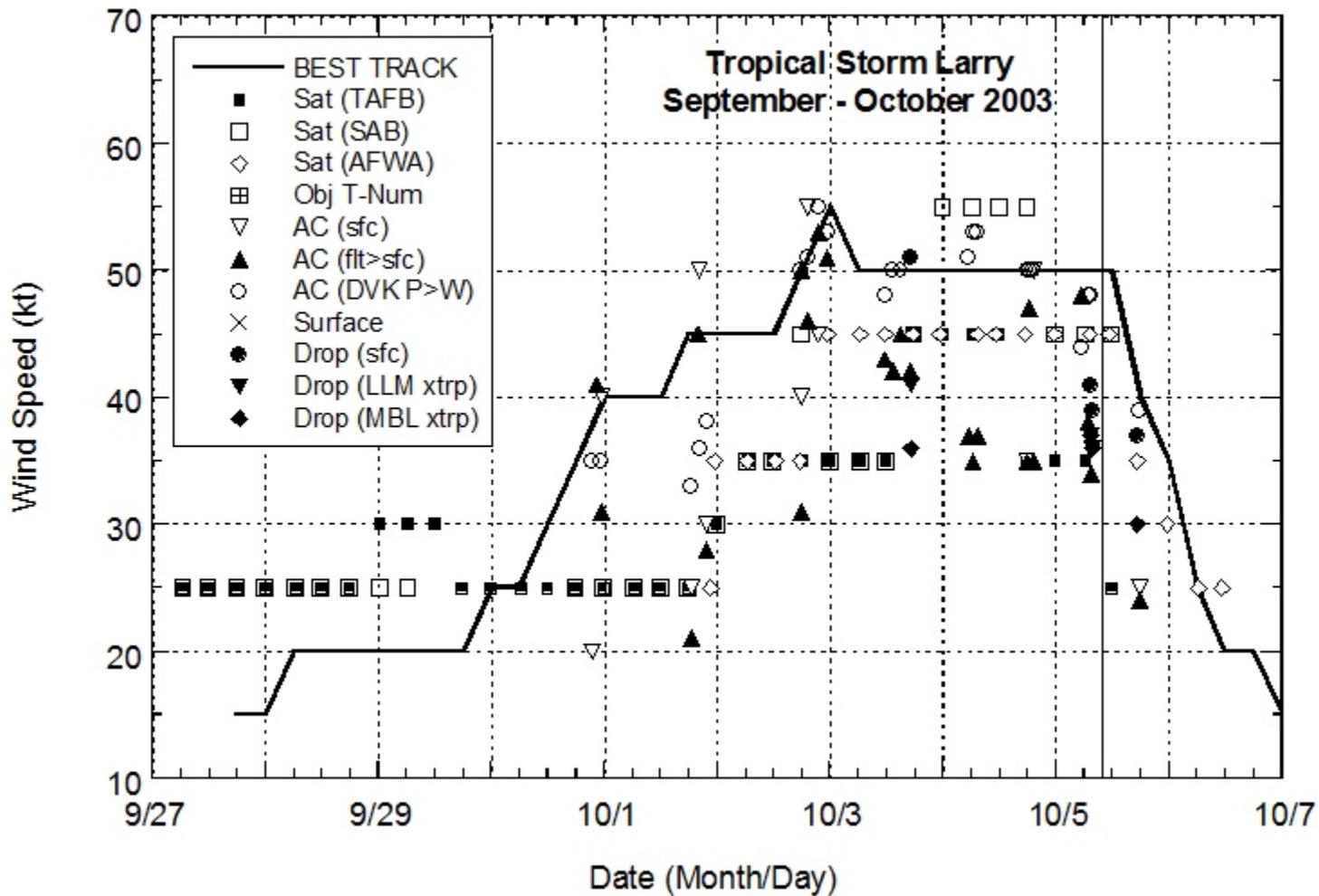


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Larry, 1-6 October 2003. Aircraft observations have been adjusted for elevation using an 80% reduction factor for observations from both 850 mb and 1500 ft. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL). Estimates during the remnant low stage are based on analyses from the National Hurricane Center and the Tropical Analysis and Forecast Branch. Landfall is indicated by the vertical line.

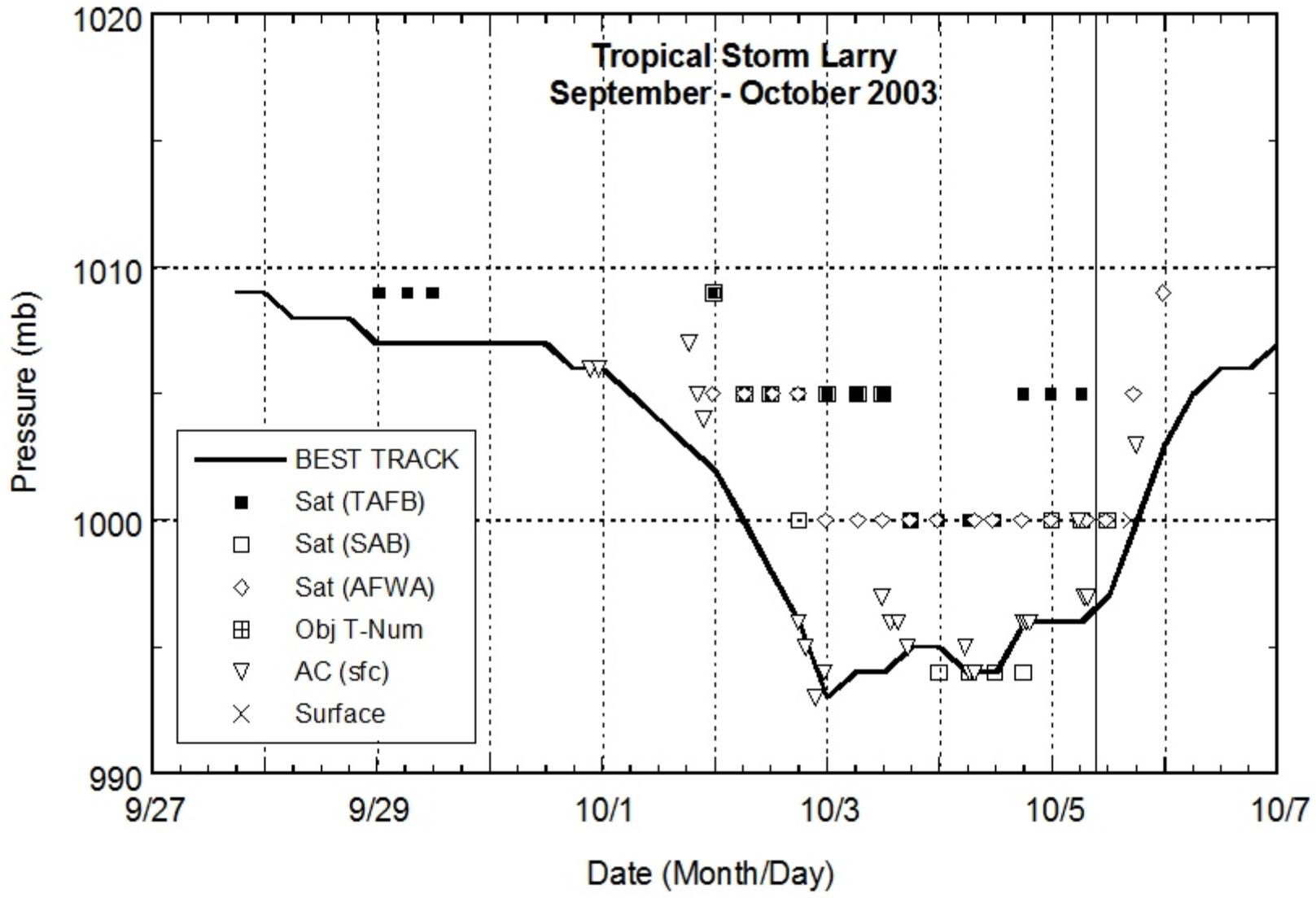


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Larry, 1-6 October 2003. Landfall is indicated by the vertical line.

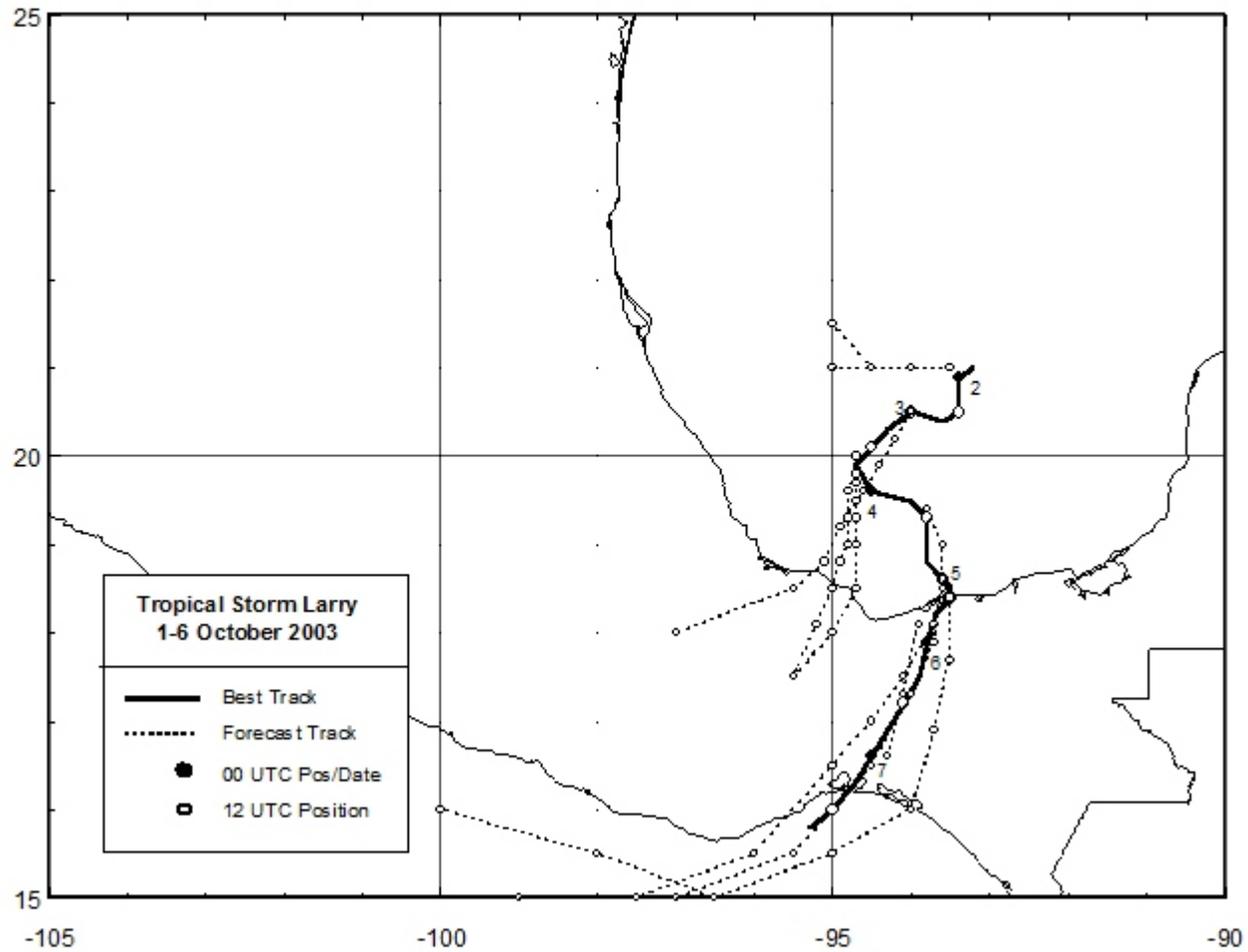


Figure 4. Selected official track forecasts (in 12h intervals and indicated by the dashed lines, with 0, 12, 24, 36, 48, and 72 h positions indicated) for Tropical Storm Larry, 1-6 October 2003. The best track is given by the thick solid line with positions given at 6 h intervals.